Core Messages

- Chronic rhinosinusitis is a very common condition in children.
- Diagnosis can be confused with a viral infection, adenoiditis or allergy symptoms.
- The majority of children respond to medical treatment.
- Coronal computed tomography scan is the imaging modality of choice in children with chronic rhinosinusitis.
- Pathophysiology in these children is blockage of the ostiomeatal complex area.
- Surgery is recommended for children who fail medical treatment.
- Endoscopic sinus surgery is the surgical modality of choice.

Contents

Development of the Sinuses ................. 203
Pathogenesis ................................ 203
Classification ............................. 204
Clinical Presentation ........................ 204
History ...................................... 204
Physical Examination ..................... 204
Laboratory Studies ......................... 204
Imaging Studies ........................... 205
Medical Treatment ......................... 205
Surgical Treatment ......................... 205
Absolute Indications ....................... 206
Relative Indications ....................... 206
Anesthesia ................................ 206
Preparation for Surgery ................. 206
Instruments Used in Surgery .............. 206
Surgical Procedure ....................... 206
Postoperative Care ....................... 208
Complications ............................ 208
Conclusion ............................... 208
References ............................... 209

Development of the Sinuses

The ethmoid and maxillary sinuses are present at birth. They can be detected radiographically at 5–6 months of age. The ethmoid sinuses grow rapidly in the first few years of life. Their growth slows significantly by 7 years of age. They reach full size by 12–14 years of age. The maxillary sinuses also grow rapidly in the first few years of life, mainly during the third and fourth years of life. After 7 years of age, growth accelerates inferiorly after the permanent teeth have erupted. They reach full growth by 15 years of age. The frontal and sphenoid sinuses start aerating by 4 years of age. Their development starts accelerating by 8 years of age and full development is reached by 18 years of age. Because of this development, the main sinuses involved in children with chronic rhinosinusitis are the ethmoid and maxillary sinuses [17].

Pathogenesis

The majority of cases of rhinosinusitis are secondary to obstruction of the ostiomeatal unit, which is an area located in the middle meatus. This obstruction will lead to poor ventilation and stasis of secretions, resulting in inflammation or infection. Obstruction can be due to several causes, the most common being anatomical anomalies, viral infections and allergic rhinitis. Certain conditions that can affect mucociliary clearance of the sinuses can also cause rhinosinusitis. Such conditions include cystic fibrosis, ciliary dyskinesia and immotile cilia. Several other conditions can affect the development of rhinosinusitis. Other than allergic rhinitis, immune deficiencies and reflux disease are conditions that may impact the response to treatment of rhinosinusitis [4, 19, 20].
Classification

Rhinosinusitis is classified into four categories:
1. **Acute rhinosinusitis**: symptoms last up to 2 weeks but not more than 4 weeks.
2. **Subacute rhinosinusitis**: symptoms last 2–4 weeks but not more than 3 months.
3. **Chronic rhinosinusitis**: symptoms last more than 3 months.
4. **Recurrent acute rhinosinusitis**: four or more episodes per year of acute rhinosinusitis.

Clinical Presentation

The diagnosis of rhinosinusitis in children can be difficult. Symptoms can be similar to those of a viral illness or may mimic allergic symptoms. Also symptoms can be similar to those of adenoiditis or sometimes reflux symptoms. Since children average six to eight colds a year, the physician should have a high index of suspicion for rhinosinusitis. Generally, most agree that if symptoms of a cold are not improving by 10–14 days, rhinosinusitis should be considered [21].

History

Symptoms of rhinosinusitis in children may vary by age. Younger children present with colored nasal discharge and cough, while older ones will complain of nasal stuffiness/obstruction and headache. The most common symptoms of chronic rhinosinusitis include nasal discharge (75%), cough (73%), nasal congestion (72%) and headache (72%) (Fig. 21.1) [10, 13, 21].

Physical Examination

Physical examination in children is usually difficult and findings are rarely helpful. Nasal endoscopy can be performed in an older cooperative child. Findings such as a concha bullosa, nasal polyps, purulent discharge or enlarged adenoids can be helpful findings (Fig. 21.2) [21].

Laboratory Studies

Diagnostic workup of children with chronic rhinosinusitis should include an allergy evaluation, immune deficiency testing, cilia biopsy and reflux evaluation.

On the basis of the findings, appropriate management should be considered.

Imaging Studies

Coronal computed tomography (CT) of the sinuses is the imaging study of choice for the evaluation of children with chronic rhinosinusitis. Plain films in these patients have a poor sensitivity and specificity. Plain films can be helpful in cases of acute rhinosinusitis.

For the CT scan to help in the management of children with chronic rhinosinusitis, it should be performed at the end of maximal medical management. A CT scan is also the preferred imaging modality in evaluating children with complicated rhinosinusitis [2, 14] (Fig. 21.3).

![Fig. 21.1. The most common presenting symptoms of chronic rhinosinusitis in that children](image1)

![Fig. 21.2. Endoscopic view with a 4-mm 0° scope of the left nasal cavity of a child showing complete blockage of the choana by adenoid tissue](image2)
**Medical Treatment**

Oral antibiotics are the mainstay of treatment of rhinosinusitis in children according to the 2005 practice guidelines [15]. High-dose amoxicillin or amoxicillin–clavulanic acid is recommended as first line of treatment. Cephalosporins or macrolides can be used as a second line of treatment or for those with penicillin allergy. There is no consensus on the duration of treatment, but most agree that it should be at least 3–4 weeks. Antibiotics can be repeated, depending on the response of the child. Adjunct treatment consists of topical nasal steroids and oral antihistamines for those with allergic rhinitis. Topical or systemic decongestants can be used, although studies have not shown them to be effective [3].

The role of intravenous antibiotics for the treatment of children with persistent or recurrent symptoms despite oral antibiotic management is still controversial. Parenteral antibiotics did not seem to contribute to a lasting resolution of children with chronic rhinosinusitis [16]. Gastroesophageal reflux disease has been noted to have a role in the pathophysiology of chronic rhinosinusitis in children. The role of reflux treatment in these children, however, is still not universally accepted [9]. Antibiotic prophylaxis to prevent infection in children who have recurrent episodes is also controversial. Little support is expressed for this approach based on the otitis media model, because of concerns of increasing prevalence of antibiotic-resistant organisms. Antibiotic prophylaxis may be used in patients with cystic fibrosis, immunodeficiency and immotile cilia disorders [1].

**Surgical Treatment**

There is no consensus and there are no guidelines on surgical treatment for chronic rhinosinusitis in children. Several surgical techniques were used in the past for the treatment of children with sinusitis, including Caldwell–Luc, intranasal ethmoidectomy, maxillary antrostomy and other external procedures. Endoscopic sinus surgery (ESS) has been the surgical treatment of choice for the last 15 years. The success with the procedure has been very rewarding [5–8].

**Absolute Indications**

Most otolaryngologists agree that the absolute indications for surgery are:

- Orbital complications, most commonly subperiosteal abscess
- Central nervous system complications
- Severe nasal polyposis
- Suspected benign lesions, tumor or fungal infection

**Relative Indications**

This category includes children who have signs and symptoms of chronic rhinosinusitis or children who have recurrent acute rhinosinusitis despite adequate medical treatment. Controversy prevails about when to operate and what procedure to perform [10]. Some physicians are of the opinion that an adenoidectomy should be performed on all children prior to ESS [18]. Agreements exist that surgery should be a last resort for children with CT evidence of disease who fail maximal medical treatment [11, 12].

Relative indications for surgery are:

- Chronic rhinosinusitis with anatomical abnormalities
- Children with cystic fibrosis who have complicated pulmonary disease
- Children with symptoms of asthma secondary to refractory chronic rhinosinusitis who are not responding to systemic steroids
- Children with immotile cilia or immune deficiency who are not responding to medical treatment of culture and irrigation.
Contraindications for surgery are:

- Children with chronic rhinitis without evidence of rhinosinusitis
- Children with a normal CT scan of the sinuses

Anesthesia

- ESS is done under general anesthesia in children.
- Pledgets impregnated with 0.5% oxymetazoline solution are used for topical vasoconstriction.
- Injection of the middle turbinates, uncinate processes, bulla ethmoidalis and septum adjacent to the middle turbinates with 1% lidocaine solution with 1:100,000 epinephrine.

Preparation for Surgery

The child is placed supine with the head of table slightly elevated. The results of a CT scan should always be in the operating suite to be used as a road map. The surgeon should be facing the patient with the monitor facing the surgeon. The surgeon can operate looking through the scope using a beam-splitter camera, or, if so trained, can operate by looking at the monitor. If the surgeon is skilled in the procedure, the eyes do not need to stay uncovered. A small tape can be used to cover them. At this point the anesthesiologist is directed to make sure that the patient received a 0.15 mg/kg decadron intravenous bolus.

Instruments Used in Surgery

The following instruments are used in surgery:

- Rigid scopes (0°, 30° and 70°) preferably 4 mm in size
- Straight and upturned Blakesley forceps of different sizes.
- Straight and upturned through-cutting forceps.
- A double-blind ostium seeker
- Short and long curved antrum cannulas.
- Right side and left side backward punch cutting forceps
- Frazier suction tubes (3, 5 and 7 French)
- A Cottle elevator
- If possible, a powered microdebrider with aggressive 2.9- and 4-mm blades

Additional instruments as deemed appropriate by the surgeon for frontal sinus and sphenoid surgery

Surgical Procedure

The 0° 4-mm scope is introduced into the nasal cavity after the pledgets have been removed (see “Anesthesia”). If more injection is needed it can be performed at this stage. With use of the cottle elevator, the middle turbinate is medialized until the uncinate process and bulla are visualized. With use of the seeker, the area of the maxillary sinus ostium is found and the ostium palpated. This can be performed in a retrograde or an anterograde manner. I prefer the anterograde technique because it prevents the posterior maxillary mucosa from stripping (Fig. 21.4). The ostium can then be widened posteriorly by removing the inferior edge of the uncinate process with straight cutting forceps (Figs. 21.5, 21.6). For retrograde technique, the right-sided backbiter can be used to remove the uncinate process anteriorly. Care should be taken not to injure the nasolacrimal duct with this technique.

A curved angled cannula is then introduced into the maxillary sinus for suction. Polyps, cysts or other debris can be suctioned and removed. All attempts should be made not to strip the mucous membrane of the sinus. The remainder of the uncinate process is then removed using up-biting and backbiting forceps. The ethmoid bulla should be now fully visualized. A straight biter is used to enter the bulla inferiorly and medially. These cells are then removed using straight and up-biting forceps (Fig. 21.7). The lamina papyracea and skull base should be visualized during this procedure to avoid any injuries.

If a posterior ethmoidectomy is needed, the ground lamella of the middle turbinate should be identified. Penetration through the lamella with a 5-mm Frazier suction tube can be performed. Any pathologic contents inside can be suctioned or removed. The anterior table of the posterior ethmoid can be widened. Removal of the mucous membrane of the sinus is not encouraged.

A posterior to anterior dissection is then performed along the skull base, which is easily identified in the posterior ethmoid air cells. This can be facilitated by using a 30° 4-mm endoscope. Exenteration of these cells along skull base can be performed using the J curette. These cells can be removed under visualization using up-biting forceps.

If a posterior ethmoidectomy is not needed, then identification of the skull base can be done anterior to the basal lamella and a similar posterior to anterior dissection is then done. At this point if the frontal si-
In most instances, once the uncinectomy is performed, a small residual piece superiorly can be identified. The seeker is used to palpate just posterior to that piece (if not present, palpation in that area is done) to enter into the frontal sinus opening. A curved suction cannula is then introduced into the sinus for inspection. In most instances, the surgeon will alternate between right and left nasal cavities using pledgets impregnated with 0.5% oxymetazoline solution for control of hemostasis while performing part of the procedure on the other side.

Once the procedure is complete, the cavities are packed with hyaluronic acid pledgets rolled up in thirds and placed in the ethmoid cavity next to the middle turbinate. A nasal drip pad is placed on the nose. The eyes are then inspected for any swelling, edema, increased pressure or ecchymosis.

### Postoperative Care

All patients are given oral antibiotics for 10–14 days. It is recommended that they sleep with the head elevated for 7 days. We discourage blowing of the nose or use of nasal sprays for 1–2 weeks. A second-look procedure is not needed on most patients. Packing will be absorbed by around 2–3 weeks and debridement in children is not necessary.

### Tips and Pearls

- Use a 4-mm scope for better visualization whenever possible. In most children a 4-mm scope can be used instead of a 2.7-mm scope.
Use the 0° and 30° scopes interchangeably during the procedure.

Avoid trauma to the middle turbinate; this will decrease the incidence of adhesions considerably.

If the frontal sinus is not diseased, stay away from the frontal recess area to prevent scarring in that area. If frontal recess surgery is needed, it should be minimal.

Extreme caution is needed while doing the uncinctomy in children to avoid orbital fat herniation.

The anterograde approach to the maxillary sinus ostium will decrease the chances of stripping the mucosa of the maxillary sinus and injury of the nasolacrimal duct because there will be no need to use the side biter anteriorly.

Complications

Complications are very rare in children. They can be intraoperative or postoperative:

1. Intraoperative complications
   (a) Cerebrospinal fluid leak. This needs to be recognized during the procedure and repaired immediately.
   (b) Orbital entry with fat herniation. In most instances the procedure can be completed and no intervention is needed.
   (c) Orbital hemorrhage with increased pressure. An immediate lateral canthotomy with removal of all the packing in the ethmoid on that side. An ophthalmology consult should be obtained.
   (d) Stripping of the maxillary sinus mucosa. This needs to be recognized otherwise, even though the bony ostium is open, the mucosa inside the sinus will be collapsed with no ventilation of the inside of the sinus.
   (e) Inadvertent injury to the middle turbinate. All attempts should be made to preserve it in place.
   (f) Bleeding. If bleeding is impairing vision considerably, the procedure should be aborted. There is no need to put the patient at risk for blood transfusion. If the bleeding is excessive with respect to the blood volume of the child, then the procedure should also be aborted.

2. Postoperative complications
   (a) Bleeding. In most instances it is self-contained. Rarely packing or examination in the operating room is needed.

(b) Adhesions. These can be very common depending on the age of the child. If they are not causing any symptoms, then they can be left alone. If symptomatic and severe, a second look to deal with them would be appropriate.

(c) Orbital swelling and ecchymosis. If eye pressure is high, then proceed as for intraoperative increased pressure. If the pressure is normal and the child is cooperative enough, remove the packing and observe.

(d) Cerebrospinal fluid leak. Place the patient on complete bed rest, with head elevation, and give stool softeners for 1 week. There is no support in the literature for a lumbar drain. If the cerebrospinal fluid leak persists, then consider endoscopic repair.

Conclusion

The endoscopic technique provides superb visualization and can be used safely for sinus surgery in children once medical therapy fails. It is important though to recognize that the majority of children with sinus disease respond to medical treatment.

References

9. Phipps CD, Wood WE, Gibson WS, et al. (2000) Gastroesophageal reflux contributing to chronic sinus disease in...